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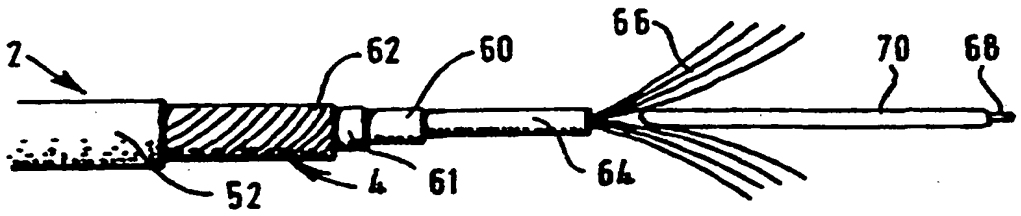


(57) Abstract

A method and apparatus for repairing a severed submarine optical fibre communications cable (2), when there is a risk of the cable core conductor (4), (60, 61, 62) being at, or going to, a high potential. As soon as the cable end (2) is recovered from the sea bed, a cable-end earthed conductor is connected to the core conductor (4) of the cable, insulation (52) is removed from the cable to the seaward side of the earthed conductor to expose the core conductor (4) and a seaward earthed conductor is clamped to that exposed core conductor. Then, the cable-end earthed conductor can be removed whereafter one or more joint members may be fitted to the exposed core conductor (4). A cable-end earthed conductor is thereafter clamped to the exposed core conductor with the joint member to the seaward side of the cable-end earthed conductor, the seaward earthed conductor is removed and the required joint members are slid on to the cable insulation (52). A gun may be used to fire an earthed pin into the cable to contact the core conductor (4) immediately or shortly after the recovery of the cable which pin serves as the cable-end earthed conductor.

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# REPAIRS TO REPEATERED SUBMARINE COMMUNICATION CABLES

This invention relates to a process and to apparatus for repairing submarine optical fibre communications cables, e.g. telephone cables, containing one or more switchable branching units.

For transmission over significant distances such cables need repeaters or regenerators which require an electrical supply. Commonly, the optical fibres are contained in a package surrounded by a core conductor which is insulated from the sea and by which the required power is supplied. The core conductor is usually at a significantly high end to end voltage in use, e.g. 14 Kv. In order to repair a damaged cable the damaged section is cut out and a new section is inserted. The cable is normally de-powered before work begins. That provides sufficient safety, since radio contact between the cable repair ship and shore stations can reliably ensure that the cable is maintained in its de-powered state throughout the repair.

There is a circumstance, however, in which it may be desired to maintain power on part of a system. This can occur if the cable includes a switchable branching unit so that a single cable leaving one shore station divides into separate branches connected to respective separate shore stations. If one branch is faulty, that section may be de-powered but the remaining branches may remain powered so that they can continue to provide service. If, however, one of the remaining branches becomes faulty, e.g. due to damage, the branching unit may respond by applying power from the remaining good branch to the original faulty branch. If repairs are being carried out to that branch at that time the situation will be extremely dangerous.

Joining the new section to the ends of the existing cable is intricate work and the use of insulating gloves etc. with which to guard against the possibility that the core conductor is at high potential, would be extremely inconvenient.

There are a number of different cable types each with its own joint and jointing procedure, but against this background, a first general aspect of the invention provides a process for repairing a submarine optical fibre communications cable connected to a branching unit and having a core conductor surrounding an optical fibre package and which can be at, or go to, high potential, the process including making a joint between two cable ends, one of which is connected to the branching unit, by: connecting a cable-end earthed conductor to the core conductor; removing insulation from the cable to the seaward side of the cable-end earthed conductor so as to expose the core conductor; clamping a seaward earthed conductor to the exposed core conductor; removing the cable-end earthed conductor; sliding one or more joint members on to the exposed core conductor; clamping a cable-end earthed conductor to the exposed core conductor so that said one or more joint members are to the seaward side thereof; removing said seaward earthed conductor; and sliding the one or more joint members on to the insulation.

The process enables the cables to be fitted with joint members while continuously maintaining a connection between the core conductor and earth.

In one cable type, the core conductor includes a copper tube containing the optical fibre package, the tube being surrounded by wire strands bedded in a water blocking compound. The process preferably includes cutting the wire strands and removing end portions thereof when the seaward earthed conductor is in place

or has been replaced, at a position spaced from the remaining insulation to expose the copper tube beyond remaining portions of the wire strands; clamping a cable-end earthed conductor to the exposed copper tube; removing the seaward earthed conductor and removing the water blocking compound from the remaining portions of the wire strands.

The connection to earth is preferably maintained by removing the cable-end earthed conductor, when said seaward earthed conductor is in place or has been replaced, and preparing the core conductor and optical fibre package for jointing.

The optical fibre package may include a king-wire. In this case preparing the optical fibre package for jointing preferably includes: exposing the king-wire beyond the core conductor; clamping a seaward earthed conductor to the king-wire at a position to seaward of its end; sliding a piece part on to the king-wire until the end of the king-wire is exposed beyond the piece part; clamping an end earthed conductor to the end of the king-wire; removing the seaward earthed conductor from the king-wire; and sliding the piece part up the king-wire. In one cable type the piece part may be a support tube.

In relation to a particular cable type, the core conductors are joined by fitting respective ferrules on each core conductor, clamping an earthed conductor to the exposed core conductor in the other said cable end or to a joint member connected electrically thereto; removing the seaward earthed conductor; and sliding a said joint member from the insulation to clamp the ferrule to a link member.

The process may include clamping an earthed conductor to exposed core conductor in the other said cable end or to a joint member connected electrically thereto; removing the seaward earthed conductor; and

sliding a said joint member from the insulation to close the joint.

The process preferably includes monitoring current flow in the earthed conductors and providing an alarm signal if the current exceeds a predetermined threshold. In practice there may be small currents in the conductor even if the core conductor is not powered up. The threshold is thus set to a suitable level not to give false alarms but to give a clear warning if there is power on the cable.

The circuit to earth through any conductors connected to the joint is preferably broken and the cable tested before the joint is insulated.

In order to remove insulation safely from the cable it is necessary to provide an earth connection to the core conductor. In accordance with a second additional or alternative aspect of the invention there is provided a process for repairing a submarine communications cable connected to a branching unit and having a core conductor surrounding a package of communication media and which can be at, or go to, high potential, the process including firing a conducting pin into the core conductor through the insulation with a cartridge powered gun. This enables the core conductor to be connected to earth either via the armour, if the cable is armoured, or through an earth lead. In the case of armoured cable the pin is fired between the strands of the armour and thus automatically connects the armour and the core conductor. However, since the insulation cannot be removed to prepare the cable for a joint, before the armour has been removed or laid back, the pin should first be connected to earth via an earth lead.

It is important that the pin should penetrate the core conductor and to facilitate that, the process preferably includes locating the gun against the cable

by means of V-shaped guides.

A third aspect of the invention extends to a submarine communications cable when repaired by a process according to the invention. In this respect it is to be noted that although the process may take place outside territorial waters, the cable as a whole is repaired thereby and an end of the cable is not only inside territorial waters but comes ashore at a landing point.

In relation to the first aspect of the invention, there is provided apparatus including two leads connected to earth at or adjacent a station in the jointing space of a cable repair ship, and having at their other ends a clamp suitable for attachment to the core conductor.

In order to allow the clamp to be fitted adjacent the insulation, at least one of the clamps has a thickness, in the direction of the length of the cable, not exceeding 10 mm.

The apparatus preferably includes means for monitoring current in each earthed conductor, and means for signalling an alarm condition if the current exceeds a predetermined threshold.

Additionally or separately, the apparatus preferably includes a switch for isolating the clamps from earth for testing the cable.

In relation to the second aspect of the invention there is provided a cartridge powered gun for firing nails or pins into a cylindrical surface, the gun having spaced generally V-shaped guides for location against the surface so as to position the nail or pin approximately on a radius of the cylinder.

One example of the invention will now be described, by way of illustration, with reference to the accompanying drawing, in which:

Figure 1 is a generalised side view, partly in

section, of one end of a joint in a submarine communications cable;

Figure 1A is a detail showing a part-prepared cable end;

Figure 2 is a front view of a clamp and earth lead for use in a process exemplarising the invention;

Figure 3 is a side view of the clamp of Figure 2;

Figure 4 is a side view of a guide for use in earthing the cable;

Figure 5 is a plan view of a mounting plate for the guide of Figure 4;

Figure 6 is a general block diagram of apparatus for monitoring the current in the earth conductors in a process exemplarising the invention; and

Figure 7 is a block diagram of a monitor unit.

Referring to the drawings, there is shown the end of a PTAT cable 2 which has been recovered from the seabed and extends to seaward to the left (in Figures 1 and 1A) to a branching unit (not shown) on the sea bed. The cable end is to be joined to another like cable end. In order to safeguard against the possibility of the branching unit putting high potential on the cable 2 it is earthed preparatory to further handling.

In particular, the cable has a composite conductor core which in use carries the high potential. The composite conductor 4 is shown exposed at later stages in Figures 1 and 1A. In the case of an armoured cable, immediately after recovery of the cable a pin is fired between the wire strands of the armour, through the insulation and penetrates, or at least contacts, the composite conductor, the pin being fired by means of a cartridge powered gun which is itself connected to earth. A suitable gun is model No. DX 450 available from Hilti. The pin thus earths the composite conductor by connecting it to the armour wires.

In the case of a light weight cable having a hard

polyethylene outer sheath, the cable is immediately earthed by means of a linesman's clamp arranged to penetrate the sheath. For example, the clamp may be furnished with a twist drill which may be rotated to penetrate the sheath whilst making a connection to the clamp which is itself earthed. Once the cable has been earthed, tension may then be taken off the cable using appropriate stoppers, whereafter the cable may again be earthed at a suitable location, using a pin fired from a cartridge gun, as described above. From this point, the procedure for both types of cable is similar.

The pin used to earth the cable preferably has a threaded head, e.g. a Hilti pin part No. M10-24-47 D12, to which an earth lead can be attached. Alternatively, an earthed lead with a saddle (or conductive plate) at one end may be provided. The saddle, in the form of a segment of a cylinder, has a radius dimensioned suitably to fit against the outer wall of the cable. Having so positioned the saddle, a pin is fired through the saddle into the cable, to connect the composite conductor to the saddle and thus to earth. In order to prevent the pin from being driven too far through the cable, a washer is preferably placed under its head before it is fired. Two pins will generally be fired through the armour or saddle into the cable.

To hold the washer, the Hilti gun is fitted with a washer holder. In addition, the gun has a special attachment illustrated in Figures 4 and 5. A mounting plate 6 has a central aperture shaped to receive the washer holder (not illustrated) and is mounted on the gun by means of screws 8. At opposite ends two guides 10 are mounted by screws 12. The guides have generally V-shaped notches 14, see Figure 4, which when mounted face away from the gun. In use the generally cylindrical outer surface of the cable 2 is received by the notches in the spaced guides, as shown in Figure 4.

This aligns the gun so that the pin is fired in a generally radial direction into the cable.

The earthed cable end is brought to the ship's jointing space where two earth leads 16 are provided. One lead 16 is shown in Figure 5. At one end each earth lead is provided with a clamp 17 and at the other with a terminal 18 attached to an earth plate 20 of a monitor unit 23 by one of a plurality of studs 22. The earth plate is mounted on a paxolin insulator 24 and electrically connected to ship's earth only by a conductor 26 in which an isolator switch 28 is provided. The conductor 26 passes through a Hall effect current sensor 30.

The end of the lead previously attached by a pin to the cable is connected to one of the studs 22 of a similar monitor unit mounted at the station in the bows or stern where the cable is brought aboard.

The monitor unit is connected by a lead 34 to a control unit 36. In the monitoring unit a controller 32 is responsive to an output from the current sensor 30 to place a signal on the lead 34 when the current sensed by sensor 30 exceeds a predetermined threshold. Inconsequential circulatory currents are thereby ignored, but if the cable is unexpectedly powered up there is quickly sufficient current flow in the conductor 26 for the controller to send a signal on the lead 34.

Responsive to the signal on lead 34, the control unit 36 activates a plurality of alarm units 38 which are spaced along the route of the cable in the ship, at least one of the alarm units being in the jointing space. Each alarm unit 38 produces a visual and a distinctive audible alarm signal so that the ship's crew and cable crew know that the cable is live.

Other similar monitor units are provided in other positions on the ship. Generally the cable will be

brought aboard over the bow or the stern and the control unit 36 has sufficient inputs available for connection to monitors to allow one in the jointing space and one each at the bow and stern. In most cases two units will suffice. The purpose of the isolation switch 28 will be explained later but is not needed in bow or stern monitors.

Referring again to Figure 1, the joint is given mechanical strength by ferrules 40 pressed on each of the composite conductors 4 of the two cable ends, only one end being in the drawing. The ferrules have flanges 44 on which a nut 46 bears. The nut is screwed on to the end of a link member 48 so completing electrical and mechanical connections between the two composite conductors 4. The joint is closed by a sleeve 50 sealed, e.g. by O-rings (not shown), to the two nuts 46.

In order to assemble the joint, the ends of the cable have to be prepared, the nuts have to be placed on the cable before the ferrule is fitted, and the sleeve 50 has to be placed on the cable before the nuts are connected by the link member 48. When working on the cable end connected to the submarine branch unit, it is simultaneously necessary to ensure that the composite conductor 4 remains connected to ship's earth. In fitting the ferrule, it is pressed on to the composite conductor, by a press which fits over the end of the cable right up to the seaward (left) end of the ferrule.

In the conventional jointing of the cable a sufficient length of insulation 52 is removed to leave a specified amount of composite conductor 4 exposed beyond the ferrule before insulant is moulded over the joint.

In order to maintain the composite conductor earthed, initially insulation is removed from the

composite conductor when that is still connected by the pin and earth lead to the monitor unit 23 in the bows or stern. The clamp 17 has two parts 54 and 56 which are then clamped together round the composite conductor 4 adjacent the end of the insulator 52 by screws 58. A central aperture 62 is dimensioned to accept the composite conductor of all conventional submarine cables. The connection to earth via the pin can now be removed so that a nut 46 and the sleeve 50 can be slid on to the cable end separately or together.

Before fitting the ferrule, the nut and sleeve need to be slid up the cable at least as far as the section of composite conductor which will remain exposed and preferably right on to the insulation 2. To accomplish that while maintaining an earth connection on the composite connector 4, the second earth lead is clamped by its clamp 17 to the composite core so that the nut 46 and/or the sleeve 50 is to seaward thereof. The first clamp is then removed so that the nut and/or sleeve can be slid on to the insulation. The first clamp 17 is now replaced adjacent the insulation.

In general, that process of earthing the composite conductor by alternate clamps can be used as many times as necessary to slide whatever joint members are needed up the cable.

Referring to Figure 1A the composite conductor 4 comprises an inner pressure-resisting copper tube 60 known as a C-section, a further copper tube 61 surrounding the tube 60, and helical wire strands 62 surrounding tube 61. In other cable types, the C-section may be omitted, or the wire strands 62 may be encased by the copper tube 61. The illustrated conductor 4 contains, within the C-section tube 60, a Hytrel package 64 of optical fibres 66. In order to fit the ferrule, the strands 62 are cut to a specified

length beyond the remaining insulation 52 and the end portions removed as indicated in Figure 1A, this being done with the seaward clamp in place or replaced after sliding the various joint parts on to the insulation as explained above. The strands 61 are bedded in a water blocking compound which is required to be removed from beneath the exposed remaining portions of the strands before the ferrule can be fitted. As it is necessary to remove the water blocking compound up to the insulation, the seaward clamp must be removed. In order to maintain the composite conductor reliably at earth potential during this operation, an earth lead is clamped to the copper tube 61 Once water blocking compound has been removed the strands are re-laid.

The operations of sliding joint members on to the cable and removing water blocking compound and relaying the strands may be performed in any convenient order. Once the operations are complete, the seaward earthed conductor is re-clamped on the strands. The inboard clamp can now be removed from the copper tube.

The inner tube 60 is now cut to the length specified by the jointing procedure, exposing the Hytrel package 64 which is then cleaned.

To give strength, the package 64 also contains a steel king-wire 68. When the joint is complete the king-wire 68 will be joined mechanically to the king-wire in the other cable end. If the composite conductor 4 were to go to high potential so, also, would the king-wire 68. The impedance of the king-wire is much greater than that of the composite conductor. Since the composite conductor is earthed, current which could be drawn through the king-wire if it was being handled by a fitter at the moment power was applied to the cable is correspondingly low compared to that in the composite conductor. However, in order to protect the fitter against that possibility, a short length of

the Hytrel is removed so as to expose the end of the king-wire using insulated or earthed strippers. A first earth lead is crimped to the inboard end of the king-wire and the Hytrel package 64 is stripped back as shown in the Figure 1A. Once the package has been stripped back, a second earth lead is attached by a crocodile clip to the king-wire, close to the remaining package 64. Different cable types may require different piece parts to be assembled on the king-wire. In the present example, a support tube is to be fitted. The king-wire is now cut to the length specified in the jointing procedure, thus removing the inboard (crimped) earth lead and the support tube 70 is slipped on to the king-wire, leaving an end of the king-wire protruding beyond the support tube, as illustrated.

The support tube is required to be positioned so that its seaward end is adjacent the end of the remaining package 64. In order to achieve that while maintaining an earth on the king-wire, a third earth lead is attached to the exposed end of the king-wire by means of a crocodile clip. The second earth lead is now removed to enable the support tube to be slid up the king-wire right to the end of the Hytrel package 64 where it is secured by means of an adhesive such as "Loctite 648".

The second earth lead is now re-clipped to the king-wire support tube 70 adjacent the end of the package 64 and the third earth wire is removed from the end of the king-wire 68.

The ferrule is then fitted on to the composite conductor: a process which involves a pressing operation in particular at its seaward end.

In order that the first clamp 17 may remain on the composite conductor while the ferrule is fitted, the clamp has a width W (in the direction of the cable's length) which does not exceed 10 mm. That allows the

length of composite conductor which remains exposed after the ferrule is fitted to remain within what are believed to be acceptable limits.

After fitting the ferrule, the second clamp is attached to the ferrule, the first clamp is removed to allow the nut 46 to be passed over the exposed composite conductor 4 and the first clamp is replaced. The sleeve is slowly removed from the king-wire and as the king-wire becomes exposed adjacent the Hytrel package, an earth lead is attached by means of a crocodile clip. The sleeve is trimmed, or a second sleeve is cut, to a length which will leave a short length of king-wire exposed. The sleeve is then slid up the king-wire removing the crocodile clip as previously. The optical fibres 66 at both cable ends are fed into respective ends of the link member and out the side thereof ready for splicing, and the nut 46 on both cable ends is screwed on to the link member 48.

Inside the link member 48, a king-wire ferrule is slid centrally over the ends of both king-wire support tubes and soldered thereto using an earthed soldering iron. The link member is then filled with a liquid resin which is allowed to cure.

The optical fibres 66 can now be spliced by known methods with the composite conductor safely connected to earth by the first clamp.

Finally before moulding, the sleeve 50 must be positioned to close the joint. There may be sufficient space inside the sleeve to allow the first clamp to have been passed therethrough before clamping to the composite conductor at the last stage. If not, the second clamp can now be attached to the exposed portion of the composite conductor at the other end of the joint or to the nut there, so that the first clamp can be removed to allow the sleeve to be assembled on the nuts 46.

In order to test the cable prior to moulding insulation over the joint, the isolator switch 28 is opened. This is signalled in the jointing space by a sounder 70 in monitor unit 23 which is connected across the unit's power supply by the normally-closed contacts of a relay RL2. The relay is held open when the isolator switch is closed by power supplied by respective contacts 28a of the switch.

In another example: PGU - Japanese LWS Joint (not illustrated), the king-wire is terminated electrically and mechanically in piece parts attached to the ferrule during preparation of the cable end. The piece parts are fitted by crimping an earth lead to the end of the king-wire. The fibres are then separated from the king-wire and an earth lead is applied to the king-wire approximately 1 metre from the ferrule. The ferrule is cut to length inboard of the earth lead. Using a second earth lead, similarly to the process described for fitting a support tube, the piece parts are slid on to the king-wire to finish the end preparation.

In yet another example: PGU - STC/NL LWS Joint (not illustrated), the king-wires of the two cable ends are joined electrically and mechanically by clamps in a link member of the joint. As previously a short length of Hytrel is removed using earthed strippers and an earth lead is crimped to the end of the king-wire. The conventional procedure is followed up to the clamping of the king-wire except that the king-wire is not cut to length. An earth lead is attached to the king-wire clamp and the king-wire clamped therein. The king-wire is then cut a short distance beyond the clamp, i.e. inboard thereof, and the cut end is bent through about 90 degrees to touch the clamp. The earth lead is then removed from the clamp and the joint is closed, the clamp is removed from the composite conductor and the insulant is moulded.

CLAIMS

1. A process for repairing a submarine optical fibre communications cable connected to a branching unit and having a core conductor surrounding an optical fibre package and which can be at, or go to, high potential, the process including making a joint between two cable ends, one of which is connected to the branching unit, by: connecting a cable-end earthed conductor to the core conductor; removing insulation from the cable to the seaward side of the cable-end earthed conductor so as to expose the core conductor; clamping a seaward earthed conductor to the exposed core conductor; removing the cable-end earthed conductor; sliding one or more joint members on to the exposed core conductor; clamping a cable-end earthed conductor to the exposed core conductor so that said one or more joint members are to the seaward side thereof; removing said seaward earthed conductor; and sliding the one or more joint members on to the insulation.

2. A process as claimed in Claim 1, wherein the core conductor includes a copper tube containing the optical fibre package, the tube being surrounded by wire strands bedded in a water blocking compound, the process including cutting the wire strands and removing end portions thereof when the seaward earthed conductor is in place or has been replaced, at a position spaced from the remaining insulation to expose the copper tube beyond remaining portions of the wire strands; clamping a cable-end earthed conductor to the exposed copper tube; removing the seaward earthed conductor and removing the water blocking compound from the remaining portions of the wire strands.

3. A process as claimed in Claim 1 or 2, including removing the cable-end earthed conductor, when said seaward earthed conductor is in place or has been

replaced, and preparing the core conductor and optical fibre package for jointing.

4. A process as claimed in Claim 3, wherein the optical fibre package includes a king-wire, the process of preparing the optical fibre package for jointing including: exposing the king-wire beyond the core conductor; clamping a seaward earthed conductor to the king-wire at a position to seaward of its end; sliding a piece part on to the king-wire until the end of the king-wire is exposed beyond the piece part; clamping an end earthed conductor to the end of the king-wire; removing the seaward earthed conductor from the king-wire; and sliding the piece part up the king-wire.

5. A process as claimed in Claim 4, wherein the piece part is a support tube.

6. A process as claimed in any preceding Claim, including joining the core conductors by fitting respective ferrules on each core conductor, clamping an earthed conductor to the exposed core conductor in the other said cable end or to a joint member connected electrically thereto; removing the seaward earthed conductor; and sliding a said joint member from the insulation to clamp the ferrule to a link member.

7. A process as claimed in any preceding Claim, including clamping an earthed conductor to the exposed core conductor in the other said cable end or to a joint member connected electrically thereto; removing the seaward earthed conductor; and sliding a said joint member from the insulation to close the joint.

8. A process as claimed in any preceding Claim, including monitoring current flow in the earthed conductors and providing an alarm signal if the current exceeds a predetermined threshold.

9. A process as claimed in any preceding Claim, including breaking the circuit to earth through any conductors connected to the joint and testing the cable

before the insulant is applied to the joint.

10. A process for repairing a submarine communications cable connected to a branching unit and having a core conductor surrounding a package of optical fibres and which can be at, or go to, high potential, the process including firing a conducting pin into the core conductor through the insulation with a cartridge powered gun.

11. A process as claimed in Claim 10, including locating the gun against the cable by means of V-shaped guides.

12. A cable when repaired by a process as claimed in any preceding Claim.

13. Apparatus for repairing submarine cables in accordance with a method as claimed in any preceding Claim, including two leads connected to earth at or adjacent a station in the jointing space of a cable repair ship, and having at their other ends a clamp suitable for attachment to the core conductor.

14. Apparatus as claimed in Claim 13, wherein at least one of the clamps has a thickness, in the direction of the length of the cable, not exceeding 10 mm.

15. Apparatus as claimed in Claim 13 or 14, including means for monitoring current in each earthed conductor, and means for signalling an alarm condition if the current exceeds a predetermined threshold.

16. Apparatus as claimed in any of Claims 13 to 15, including a switch for isolating the clamps from earth for testing the cable.

17. A cartridge powered gun for firing nails or pins into a cylindrical surface, the gun having spaced generally V-shaped guides for location against the surface so as to position the nail or pin approximately on a radius of the surface.

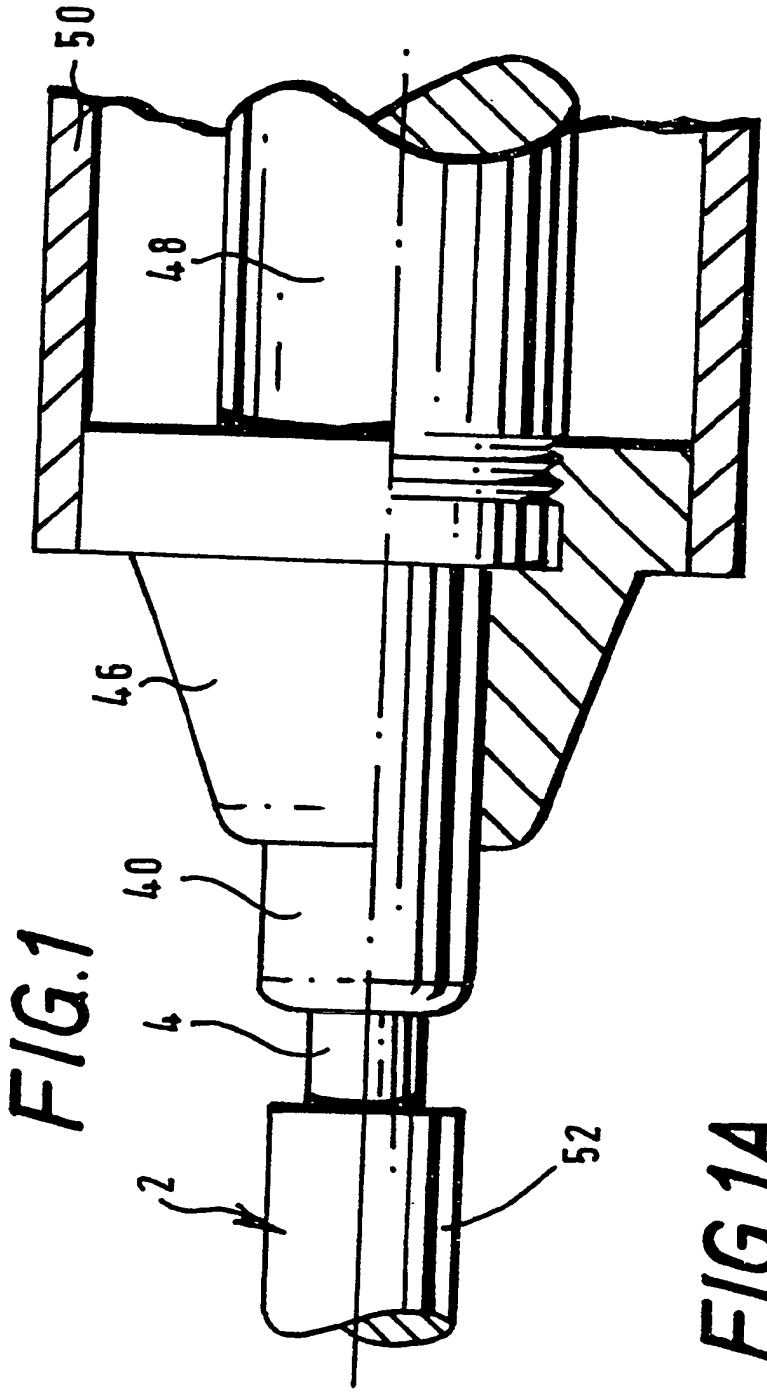



FIG.1

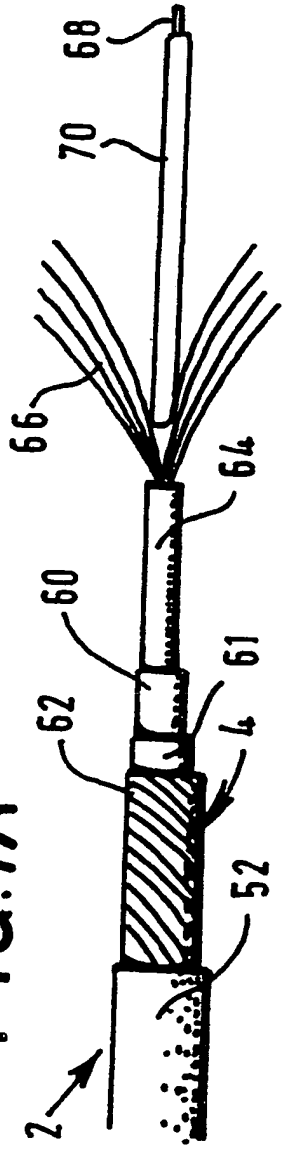



FIG.1A

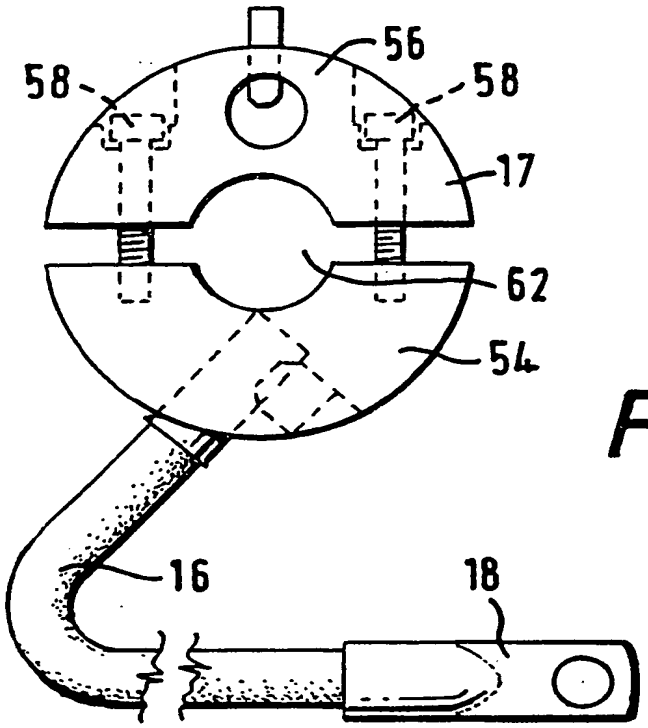



FIG. 2

FIG. 3

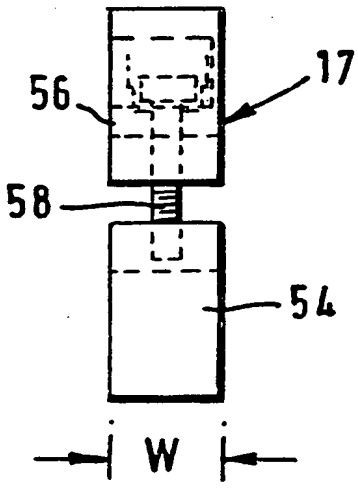
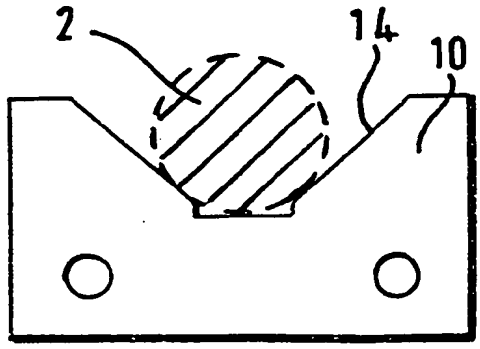



FIG. 4



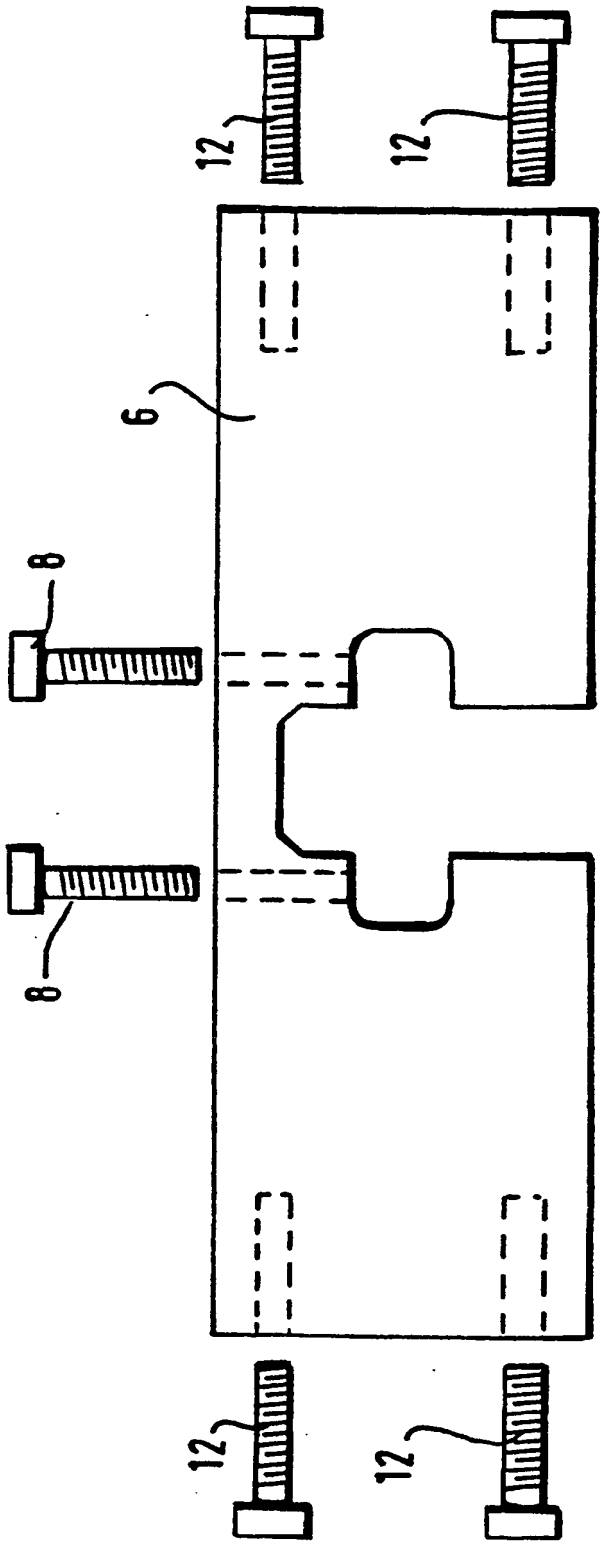
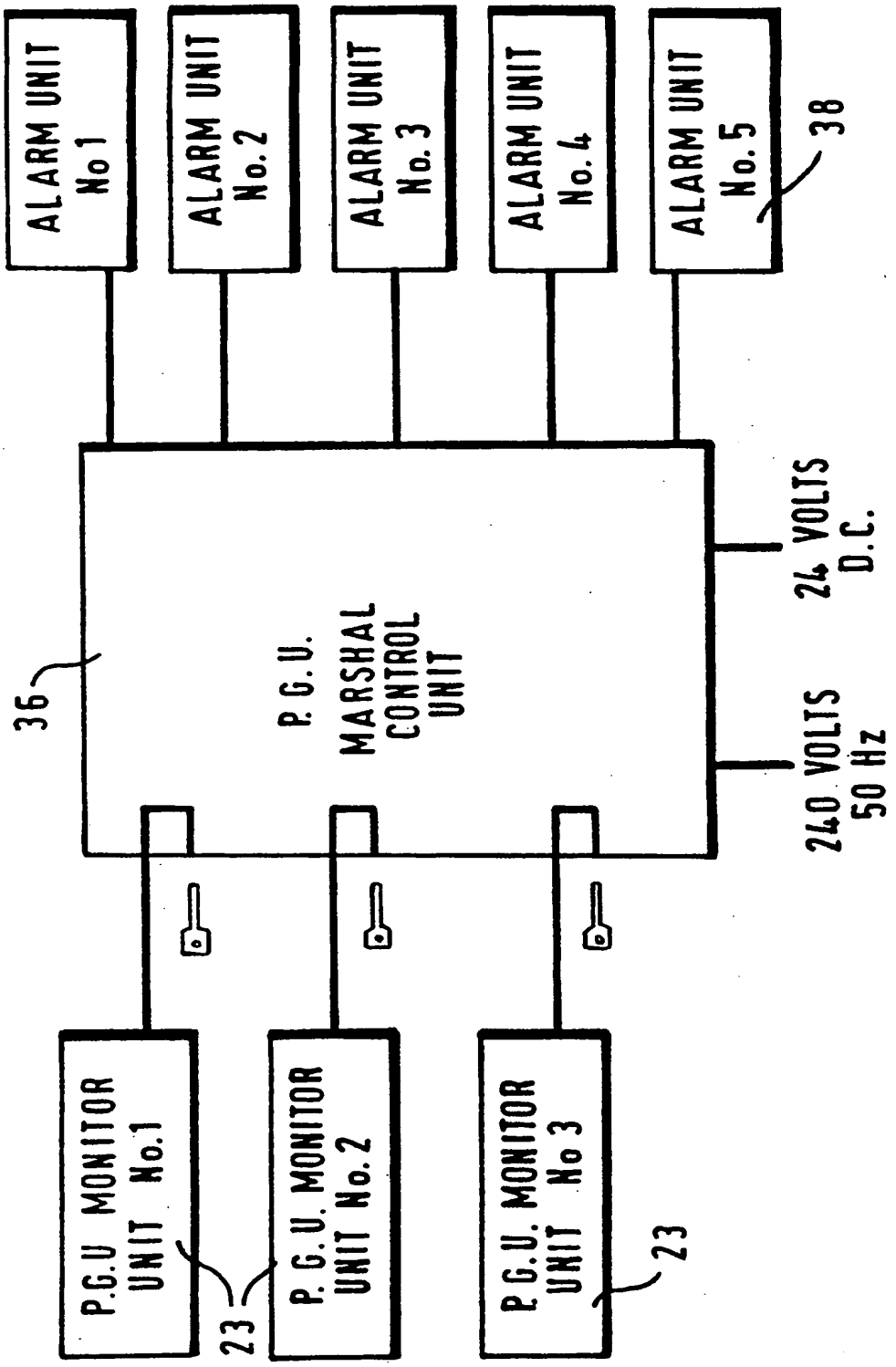



FIG. 5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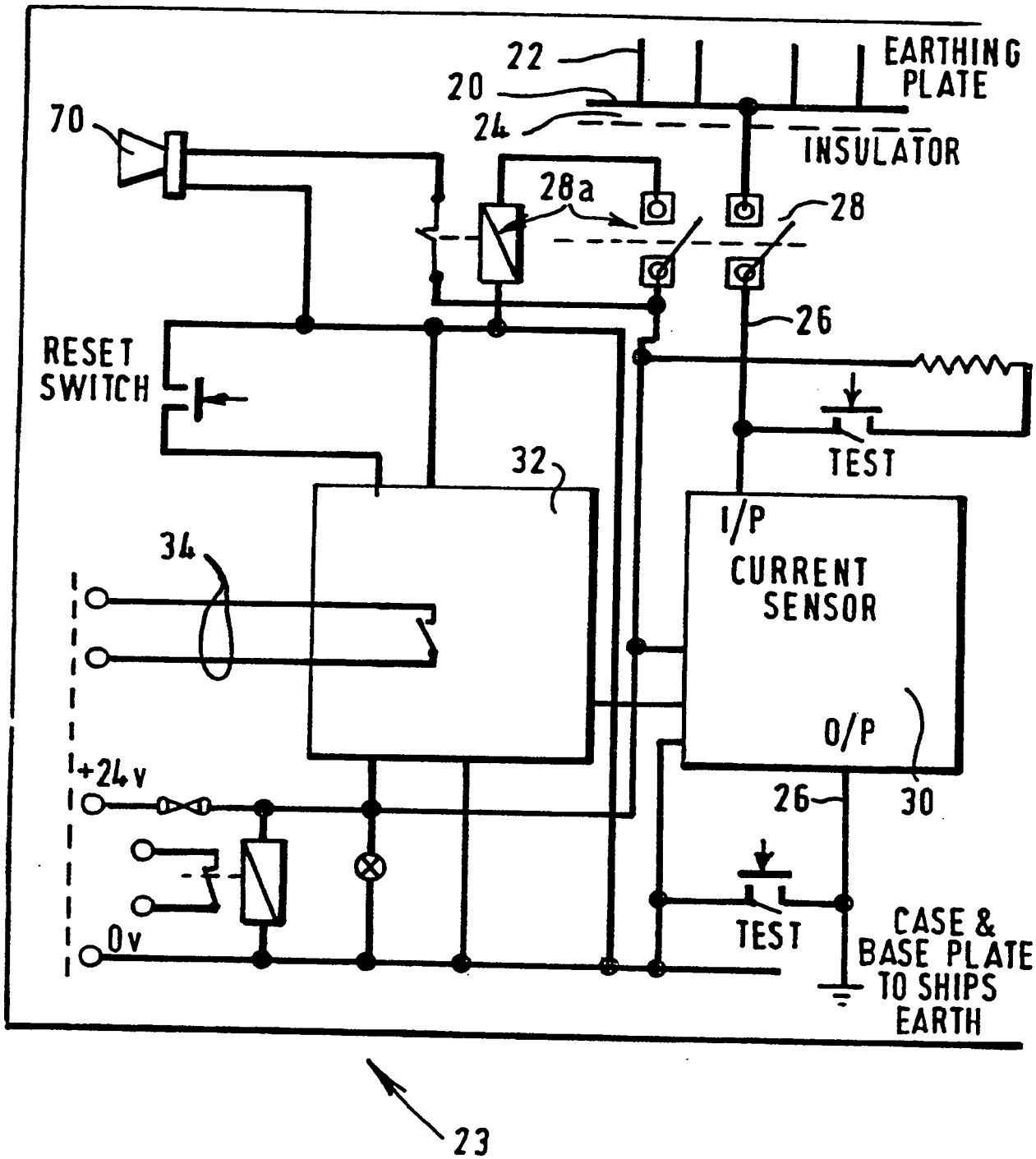
ALARM UNIT No.2
ALARM UNIT No.3
ALARM UNIT No.4
ALARM UNIT No.5
38
24 VOLTS D.C.
240 VOLTS 50 Hz
36
P.G.U. MARSHAL CONTROL UNIT
P.G.U MONITOR UNIT No.1
P.G.U. MONITOR UNIT No.2
P.G.U. MONITOR UNIT No 3
23
23

FIG.6

FIG.7


22
20
24
EARTHING PLATE
INSULATOR
70
28a
28
26
RESET SWITCH
TEST
32
34
I/P
CURRENT SENSOR
O/P
+24v
26
30
TEST
0v
CASE & BASE PLATE TO SHIPS EARTH
23

# INTERNATIONAL SEARCH REPORT

national application No.
PCT/GB 94/00189

## A. CLASSIFICATION OF SUBJECT MATTER

IPC6: H02G 1/14
According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC6: H01R, H02G

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

WPI, CLAIMS

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

| Category* | Citation of document, with indication, where appropriate, of the relevant passages | Relevant to claim No. |
|---|---|---|
| X | DE, A1, 3116518 (HÜLSWITT, PETER), 27 January 1983 (27.01.83) -- | 17 |
| X | DE, A1, 3506201 (WALTER ROSE GMBH & CO KG), 28 August 1986 (28.08.86) -- | 17 |
| X | Derwent's abstract, No 92- 55672/07, week 9207, ABSTRACT OF SU, 1636899 (MOSENERGO ASSOC), 23 March 1991 (23.03.91) -- | 17 |

☐ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

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"&" document member of the same patent family

| Date of the actual completion of the international search | Date of mailing of the international search report |
|---|---|
| 20 April 1994 | 27.05.94 |
| Name and mailing address of the International Searching Authority<br>European Patent Office, P.B. 5818 Patentlaan 2<br>NL-2280 HV Rijswijk<br>Tel. (+31-70) 340-2040, Tx. 31 651 epo nl,<br>Fax: (+31-70) 340-3016 | Authorized officer<br>Magnus Westöö |

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INTERNATIONAL SEARCH REPORT
Information on patent family members

S[redacted]441

26/02/94

International application No.
PCT/GB 94/00189

| Patent document cited in search report | Publication date | Patent family member(s) | Publication date |
|---|---|---|---|
| DE-A1- 3116518 | 27/01/83 | NONE | |
| DE-A1- 3506201 | 28/08/86 | DE-A- 3513595 | 16/10/86 |
| | | EP-A,B- 0192057 | 27/08/86 |